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UK CL (Edition B) H4L LUF

(54) Radio communications systems

(57) A radio communication system comprising apparatus selectively arranged 7 for signal transmission in one or other of two modes, the first mode comprising a frequency modulation mode 1 for the transmission of information 4 at a carrier frequency which is changed or hopped 5 and the second mode comprising an amplitude modulation mode 8 for the transmission of data wherein the carrier frequency of transmitted bits is changed or hopped 9 from bit to bit according to a predetermined sequence or pattern.

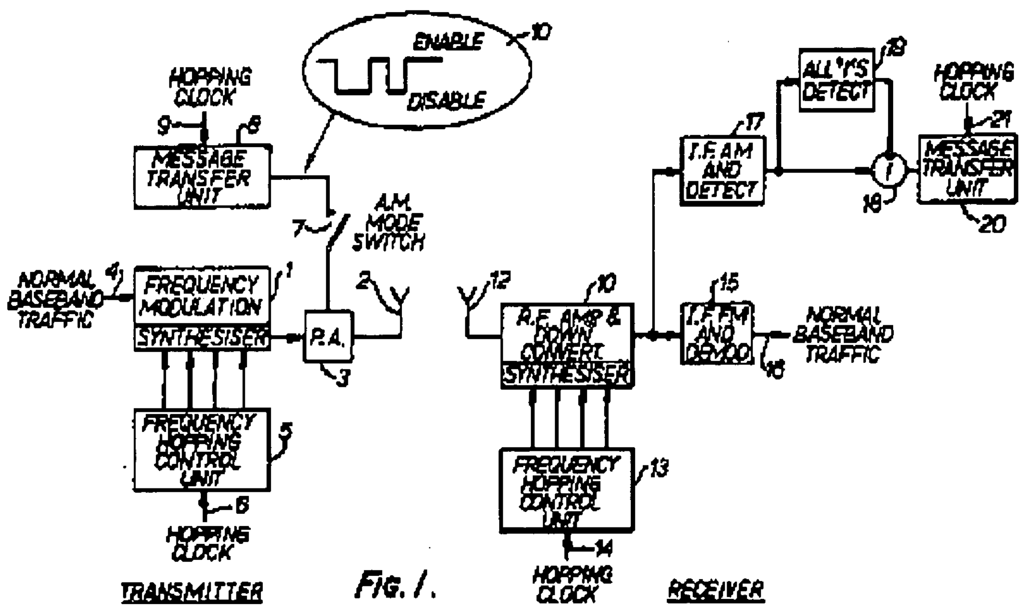

FIG. 1.

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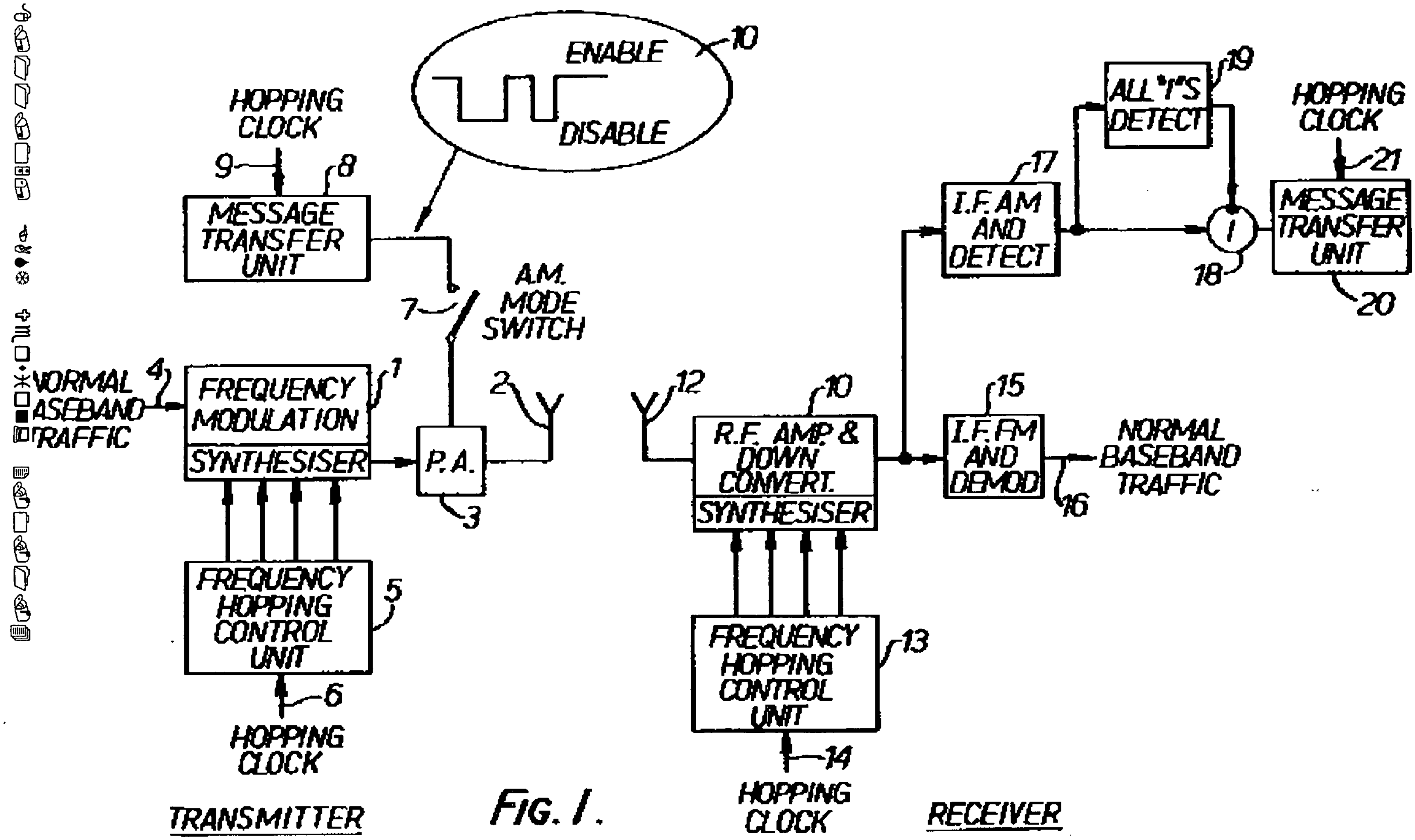
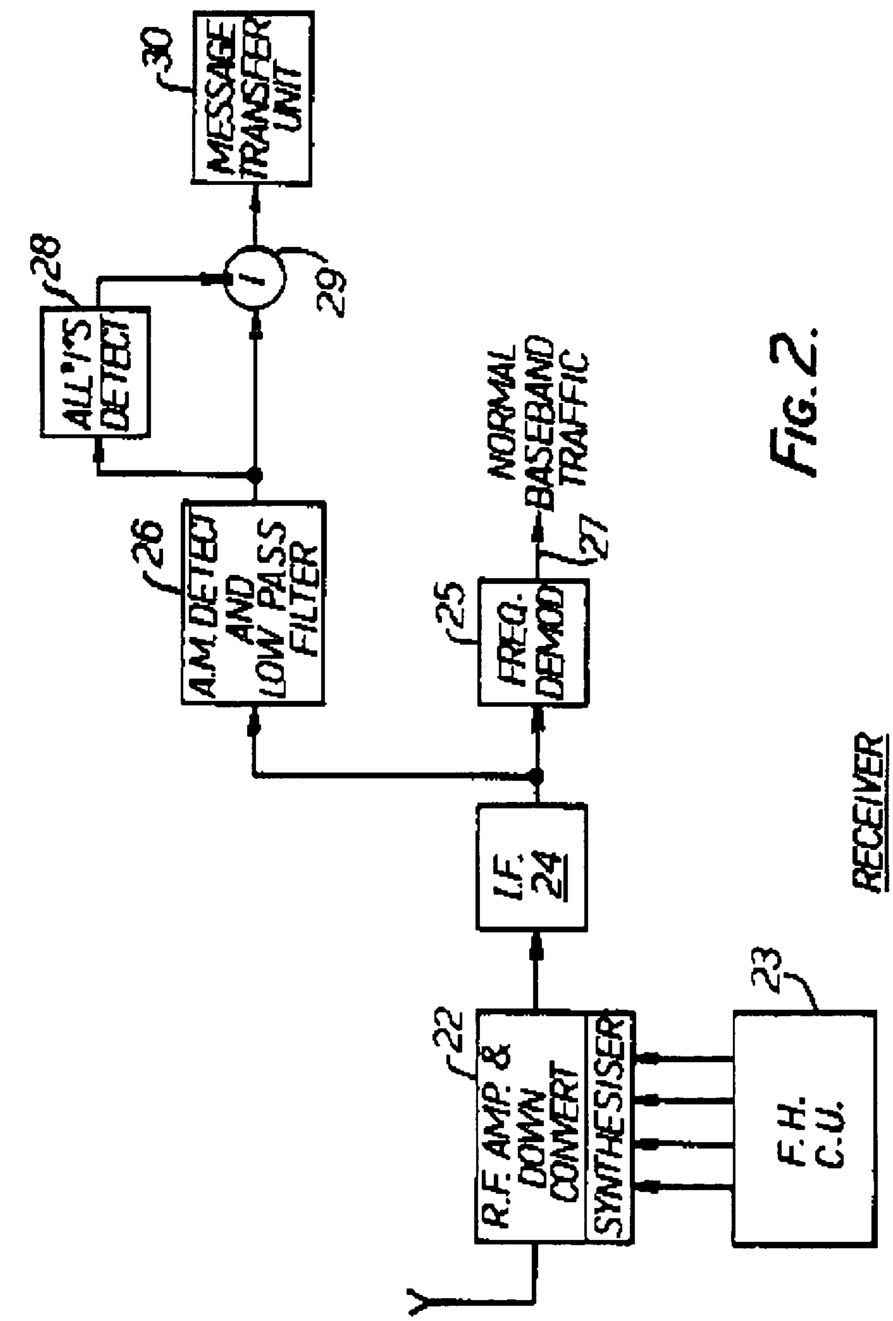

HOPPING CLOCK
9
8
MESSAGE TRANSFER UNIT
ENABLE
DISABLE
10
A.M. MODE SWITCH
7
NORMAL BASEBAND TRAFFIC
4
FREQUENCY MODULATION
SYNTHESISER
1
P.A.
3
2
FREQUENCY HOPPING CONTROL UNIT
5
6
HOPPING CLOCK
TRANSMITTER
12
R.F. AMP. & DOWN CONVERT.
SYNTHESISER
10
FREQUENCY HOPPING CONTROL UNIT
13
14
HOPPING CLOCK
I.F. AM AND DETECT
17
ALL "1"S DETECT
19
18
HOPPING CLOCK
21
MESSAGE TRANSFER UNIT
20
I.F. FM AND DEMOD
15
16
NORMAL BASEBAND TRAFFIC
RECEIVER

FIG. 1.



MESSAGE TRANSFER UNIT
30
28
ALL 1'S DETECT
1
29
26
A.M. DETECT AND LOW PASS FILTER
NORMAL BASEBAND TRAFFIC
27
25
FREQ. DEMOD
I.F. 24
22
R.F. AMP. & DOWN CONVERT
SYNTHESISER
23
F.H. C.U.
RECEIVER

FIG. 2.

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IMPROVEMENTS IN OR RELATING TO RADIO COMMUNICATION SYSTEMS

This invention relates to radio communication systems.

A large proportion of tactical radio communication is provided by equipment which operates in the 30 to 76MHz VHF band. Typically this equipment employs narrow band frequency modulation appropriate to radio channel bandwidths of 25KHz.

Considerable attention is being given to organising tactical radio communications so that electronic jamming can be resisted. One established technique is the use of frequency hopping in which the radio frequency used for communication is rapidly hopped in a random manner so that jammers will be forced to possess an even more commensurate degree of agility before they can expect to search and find the victim radio channel before it has hopped again.

The application of frequency hopping techniques to a radio communication organisation involves a considerable increase in radio equipment complexity and the distribution of frequency hopping code and timing information throughout the radio network, which gives rise to a requirement for increased levels of management and organisation procedure, and these problems tend to increase as hopping rates are increased. However, the use of low hopping rates - slow hopping - can be expected to provide little protection against the next generation of agile jammers which are likely to be designed to suppress even relatively fast hopping systems. Therefore, there could be distinct advantages to be conferred on a frequency hopping system which could be configured to hop at a

slow rate and yet be invulnerable even to fast following jammers. It is an object of the present invention to provide such a system.

According to the present invention a radio communication system comprises apparatus arranged for signal transmission in one or the other of two modes, the first mode comprising a frequency modulation mode for the transmission of information at a carrier frequency which is changed or hopped and the second mode comprising an amplitude modulation mode for the transmission of data wherein the carrier frequency of transmitted bits is changed or hopped from bit to bit according to a predetermined sequence or pattern.

According to one embodiment of the present invention a radio communication system comprises apparatus arranged for the transmission of data in one or the other of two modes, the first mode comprising a frequency modulation mode for the transmission of information at a carrier frequency which is changed or hopped and the second mode comprising an amplitude modulation mode for the transmission of data at a bit rate corresponding to the hopping rate wherein the carrier frequency of transmitted bits is hopped from bit to bit according to a predetermined sequence or pattern, which corresponds to the frequency hopping sequence or pattern utilized for the transmission of information in the first mode.

Preferably the hopping rate is arranged to be regular whereby transmission is effected at each selected frequency for the same dwell period before hopping to the next

frequency is effected.

Thus it will be appreciated that data transmission in the second mode comprises transmitting a signal at a selected carrier frequency (which may or may not itself be frequency modulated) thereby to indicate a '1' bit, the absence of a signal expected at a selected frequency being indicative of a '0' bit, or visa versa.

According to one embodiment of the invention means may be provided responsive to a jamming or interferring signal for changing the system automatically from the first to the second mode or responsive to the jamming signal for indicating that such a change might be desirable.

The crux of a system according to this invention is that it should be capable of operating with normal traffic signals in an unjammed environment and that it should operate with a reduced traffic rate when it is exposed to heavy jamming. Let us consider firstly a conventional frequency modulated radio link which provides normal traffic signals at 16Kb/s. If this link is now made to frequency hop at a relatively low rate of say ten hops per second, then in order to maintain normal traffic, it would dwell on each of its frequency channels for approximately one tenth of a second while transmitting its normal 16Kb/s information. (Note that the bit rate over the radio link may have to be increased slightly beyond 16Kb/s in order to compensate for the small interruption of communication which must occur whilst the radio link is changing between two frequencies). If, now, the radio link is exposed to severe jamming so that the normal traffic information is obliterated at the victim receiver, then the

link may change to a difference mode of operation in which the presence of a binary '1' may be indicated by the whole of the transmission during the dwell on a radio frequency (for a duration of one tenth of a second) and a binary '0' by no transmission during the dwell on that frequency, (or vice-versa). This mode effectively corresponds to amplitude modulation at the hopping rate. In this situation, even the use of a (future) ultra fast following jammer will only assist the radio link transmission, since the jammer cannot radiate a signal into the link frequency channel should a binary '0' be transmitted unless either he knows the hopping code or barrage jamming is employed. In effect, when the link is being used in a low (hopping) rate singalling mode (the second mode), following jammers serve only to amplify wanted radio link transmissions.

Note that in this low rate a.m. second mode of operation of the link, the transmitter will only be radiating for, on average, half the time, since it may be assumed that the average number of '1s' and '0s' are equal. If the following jammer detects this mode of operation it would logically stop jamming in order to avoid re-transmissions of the victim radio links low rate information. In this situation there are two possibilities: either it can be arranged for the radio link to transmit at a spurious frequency when a binary '0' is signalling so that the jammer never knows when the link is operating in the a.m. mode, or it can be arranged for the jammer to recognise the a.m. mode of operation so that it stops jamming; the link can then be restarted so as to

operate back in the full traffic mode. This leaves the jammer with the choice of either not jamming the link at all or enhancing the range of low rate transmissions. The preceding logic assumes that the radio link transmitter can, as required, transmit FM at the normal (or less than normal) traffic rate while operating in the a.m. mode.

Some embodiments of the invention will hereinafter be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a block schematic diagram of a signal transmission system and

Figure 2 is a block schematic diagram of the receiver of an alternative signal transmission system.

In order to implement the invention, a standard f.m. receiver may be modified to operate in the a.m. mode in two different ways. For the best anti-jamming performance an additional narrow band IF amplifier and filter may be provided to minimise the effective RF bandwidth of the link. Ideally, the synthesiser associated with this narrow band IF should be capable of operating with a reduced channelling appropriate to the reduced IF bandwidth. A possible block diagram of such a system is shown in Figure 1.

Referring now to Figure 1 the system comprises a transmitter comprising a frequency modulation unit and synthesiser 1 arranged to feed a transmission aerial 2 via a power amplifier 3. The synthesiser 1 is fed with normal modulation signals via line 4 and with frequency hopping control signals via a frequency hopping control unit 5. The

frequency hopping control unit 5 is operated under the control of a hopping clock (not shown) which provides for the frequency hopping control unit a hopping clock signal via line 6. In order to facilitate a.m. mode operation a switch 7 is provided via which a.m. modulation signals are fed from a message transfer unit 8 which receives also signals from the hopping clock via line 9 and when the switch 7 is closed AM modulation is effected at a bit rate determined by the hopping clock. Operation is illustrated in this mode by means of inset waveform diagram 10. Apparatus in the receiver for receiving signals from the transmitter comprises an RF amplifier and frequency conversion unit 11 fed from a receiver aerial 12, the RF amplifier and frequency conversion unit including a synthesiser which is fed from a frequency hopping control unit 13. The frequency hopping control unit is operated in synchronism with the frequency hopping control unit 5 under control of a hopping clock (not shown) signals from which are fed to the control unit 13 via a line 14. Output signals from the RF amplifier and conversion unit 10 are fed to an I.F. stage and frequency demodulator 15 which provides on output line 16 demodulated signals when the system is operated in a first f.m. hopping mode.

Output signals from the unit 10 are fed also to an IF amplifier and AM detector 17, output signals from the AM detector 17 being fed to a gate 18 which is closed when all '1's are detected by a bit detector 19. When the gate 18 is open signals are fed to a message transfer unit 20 operated synchronously with the hopping clock by means of a signal applied thereto on line 21.

An alternative, simplified approach is possible comprising a receiver as shown in Figure 2 where a single conventional IF amplifier and filter is used which feeds both a conventional f.m. discriminator and a parallel a.m. detector. The narrow bandwidth appropriate to the a.m. mode of operation is achieved using a low pass filter following the a.m. detector. This particular configuration will exhibit the same processing gain to jamming as the conventional receiver provided the bandwidth of the jamming signal is restricted to that of the low rate a.m. operation.

Referring now to Figure 2 the receiver comprises an RF amplifier/frequency conversion unit 22 including a synthesiser which is operated under control of the frequency hopping control unit 23. Output signals from the RF amplifier/frequency converter 22 are fed to an IF stage 24 and from the IF stage to a frequency demodulator 25 on the one hand and an a.m. detector and low pass filter 26 on the other hand. Output signals from the frequency demodulator 25 are provided on line 27 and comprise normal baseband traffic signals whereas output signals from the a.m. detector and low pass filter 26 are fed to an all '1's detector 28 and a gate 29 which operate in combination as described in connection with the all '1's detector 19 and the gate 18 shown in Figure 1. Output signals from the gate 29 are fed to a message transfer unit 30.

Change of mode of operation from the f.m. mode to the a.m. mode may be indicated by a change from a constant stream

of binary '1's from the output of the a.m. detector to a randomly fluctuating stream of intermingled 0's.

Note that, if desired, operation of a hopping link in the a.m. mode need not be restricted to low rate hopping. The same principles would apply if the link were hopped at high rate, when more information could be transmitted over the link when subjected to severe jamming. It can be expected that such a system would be more expensive than the low rate system and would require more complex control.

When the link is operated in the a.m. mode the information bandwidth is approximately equal to the hopping rate. Therefore, low rate hopping may be used to provide an enhanced radio range relative to the normal rate signalling mode of operation when no jamming is present, since, in the low rate mode, the receiver effective noise bandwidth may be reduced from its normal value (15KHz channelling) down to that appropriate to the low hopping rate.

CLAIMS

1. According to the present invention a radio communication system comprises apparatus arranged for signal transmission in one or other of two modes, the first mode comprising a frequency modulation mode for the transmission of information at a carrier frequency which is changed or hopped and the second mode comprising an amplitude modulation mode for the transmission of data wherein the carrier frequency of transmitted bits is changed or hopped from bit to bit according to a predetermined sequence or pattern.

2. A radio communication system as claimed in claim 1 comprising apparatus arranged for the transmission of data in one or the other of two modes, the first mode comprising a frequency modulation mode for the transmission of information at a carrier frequency which is changed or hopped and the second mode comprising an amplitude modulation mode for the transmission of date at a bit rate corresponding to the hopping rate wherein the carrier frequency of transmitted bits is hopped from bit to bit according to a predetermined sequence or pattern which corresponds to the frequency hopping sequence or pattern utilized for the transmission of information in the first mode.

3. A radio communication system as claimed in claim 2 wherein the hopping rate is arranged to be regular whereby transmission is effected at each frequency for the

same dwell period before hopping to the next frequency is effected.

4. A radio communication system as claimed in any preceding claim wherein means are provided for changing automatically the operational mode of the system from the first mode to the second mode in response to the detection of an interferring signal.

5. A radio communication system as claimed in any of claims 1 to 3 wherein means are provided responsive to an interferring signal for indicating that a change from one mode to the other would be desirable.

6. A radio communication system as claimed in claim 1 and substantially as hereinbefore described with reference to the drawings.

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Amendments to the claims have been filed as follows

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1. A radio communication system comprising apparatus arranged for signal transmission in one or other of two modes, the first mode comprising a frequency modulation mode for the transmission of information at a carrier frequency which is changed or hopped and the second mode comprising an amplitude modulation mode for the transmission of data wherein the carrier frequency of transmitted bits is changed or hopped from bit to bit according to a predetermined sequence or pattern.

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Patents Act 1977 13
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

8005320.0

Relevant Technical fields

(i) UK Cl (Edition B) H4L (LUF)

(ii) Int Cl (Edition)

Search Examiner

P HAYWARD

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

14.5.80

Documents considered relevant following a search in respect of claims

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

SF2(p)

Category	Identity of document and relevant passages	Relevant to claim(

Categories of documents

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